REMARKS

Claim 48 has been amended to correct a minor typographical error. No new matter has been added.

Applicants respectfully request that the present application be reconsidered and the claims allowed for the following reasons.

The Invention

The present invention pertains broadly to a process for fabricating a semiconductor device that has a support member, such as a lead frame, to which a semiconductor die or chip is attached using a die-bonding material. More particularly, the first preferred embodiment in accordance with the invention is a process for fabricating a semiconductor device characterized by the step of bonding a semiconductor device to a support with an organic die-bonding film at conditions of temperature 100-250°C and pressure of 0.1-30 gf/mm^2 to produce a bonded chip wherein the organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher. All of the remaining dependent claims represent other preferred embodiments that are modifications of the first preferred embodiment.

The advantage of the claimed invention and the various modifications is that a process is provided for the manufacture of semiconductor devices that have fewer flow cracks and other defects that devices made with silver paste have because the fabrication process of the present invention produces semiconductor devices that are less prone to formation of reflow cracks during the fabrication process. Thus, the semiconductor devices made by the process of the

claimed invention are more reliably manufactured and have better durability than semiconductor devices manufactured by the prior art fabrication processes.

The Rejections

Claims 25-30, 33, 36, 48, 49, 52, 55, 58-60 and 63-65 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita et al. (U.S. Patent 5,406,124). Claims 31, 32, 34, 35, 37, 38, 50, 51, 53, 54, 56, 57, 61, and 62 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita in view of Hozoji (Japanese document JP5-218107). Claims 39, 42, and 45 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita in view of Sakumoto (U.S. Patent 5,277,972). Claims 40, 41, 43, 44, 46 and 47 stand rejected under 35 U.S.C. 103(a) as unpatentable over the combination of Morita and Hozoji, and further in view of Sakumoto.

Applicants traverse the Examiner's rejection for the following reasons.

Applicant's Arguments

The Morita reference discloses an "insulating adhesive tape" that includes a base supporting film and an adhesive layer formed on at least one surface thereof (see Abstract). The adhesive layer is a thermoplastic polymer comprising a thermoplastic polyimide, wherein the polymer has a glass transition temperature ranging from 180°C to 280°C and an elastic modulus ranging from 10^{10} dyne/cm^2 to 10^{11} dyne/cm^2 at 25°C, wherein the elastic modulus includes a value ranging from 10^2 dyne/cm^2 to 10^9 dyne/cm^2 at a temperature between 250°C and 300°C. The Morita reference discloses that the thermoplastic polymer has a water absorbing ratio of less than 1.2% (col. 9, lines 14-16); however, Morita does not explicitly state to what the percentage is relative. Specifically, the Morita reference only describes **% by weight** (col. 9, lines 35-39

and lines 53-55); therefore, it is suggested that Morita describes that the water absorbing ratio is less than 1.2% by weight. **There is nothing in the Morita et al. reference to teach, or even suggest, that the water absorbtion is 1.5% by volume or less** as required by claim 28.

The Morita reference also discloses that the adhesive temperature for bonding IC chips to lead frames using the adhesive tape is selected from the range of 250-450°C (preferably 270-400°C) and the adhesive pressure is 1-50 kg/cm^2 (preferably 5-30 kg/cm^2), (col. 14, lines 3-14). However, the presently claimed invention recites bonding conditions to include the combination of a bonding temperature of 100-250°C and a bonding pressure of 0.1-30 gf/mm^2 as recited in independent claim 25.

Furthermore, Applicants point out that the Examiner admits that the Morita reference does not disclose a "17 degree peel strength of 0.5 Kgf/5mm x 5mm chip or above" (Office Action, dated December 26, 2001, page 6, lines 1 to page 7, line 2), but the Examiner asserts that in the absence of unexpected results that such an increase in peel strength would be "ascertainable by routine experimentation and optimization" (Office Action, dated December 26, 2001, page 6, lines 13-17); however, the Examiner does concede that "a disclosure that the limitations...produce an unexpected result, or are otherwise critical" would rebut any established *prima facie* case of obviousness (Office Action, dated December 26, 2001, page 6, line 20 to page 7, line 2)..

Applicants produce such a disclosure and make such a rebuttal. Applicants submit for the Examiner a Declaration by Takashi Masuko (hereafter the "Masuko Declaration"), dated March 5, 2002, attached herewith and filed in accordance with 37 C.F.R. 1.132. The Masuko Declaration establishes that when the novel film (see Section 7 on page 3) in accordance with the present invention is compared to the prior art film (see Section 6 on page 3) disclosed by Morita

et al. under identical experimental conditions, the result is that the novel film of the present invention demonstrates an "unexpected invulnerability" (page 7, lines 4-8). As shown in Table 2, when evaluating the two films for the occurrence of reflow cracks it was shown that while **all** of the Morita film samples under the given die-bonding conditions manifested reflow cracks, **none** of the samples made in accordance with the present invention had reflow cracks. In addition, when peel strength was measured (Matsuko Declaration, section 8) the peel strength was significantly greater for the novel film of the present invention over the Morita film (see Table 1). In fact, when the die-bonding condition was set as "250°C x 30gf/mm^2 x 20 sec," all of the chips made using the novel film were destroyed during testing because the bond strength was stronger than the chip. In other words, the bond strength of the material in accordance with the present invention was stronger than what this particular test could measure! Clearly, this is another superior and unexpected result.

In view of the Masuko Declaration, the *prima facie* case of obviousness standing against independent claim 25 has been sufficiently rebutted to be overcome by the results because of the superior and unexpected result of the material having "a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher" as recited in claim 25.

Thus, the Morita et al. reference can not anticipate, or render obvious, the subject matter of base claim 25 because Morita et al. does not teach, or even suggest, (a) the "organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher," and (b) the combination of conditions of "temperature 100-250°C and pressure of 0.1-30 gf/mm^2." Morita et al. also do not teach, or even suggest, bonding with an organic die-bonding film having a "water absorbtion of 1.5% by volume or less" as recited in claim 28. However, even if a *prima* facie case of obviousness can be inferred from the teachings of Morita (which it can not) it is

plainly shown that the present invention provides superior and unexpected improvements in both peel strength and reflow crack development over the Morita et al. adhesive tape. Specifically, the peel strength of the novel film in accordance with the present invention is consistently and significantly stronger than the peel strength of the Morita et al. film, and in some cases the peel strength of the instant novel film was so strong that it could not be fully measured using the present techniques. In addition, the novel film in accordance with the present invention was "unexpectedly invulnerable" to the formation of reflow cracks, whereas 100% of the Morita films developed reflow cracks.

Hozoji discloses a "resin-sealed semiconductor device" wherein a die pad and a semiconductor element are fixed by using an adhesive layer in which a base material having a low moisture absorption rate (i.e. glass cloth or metal foil) is impregnated or coated with a bisphenol type epoxy resin, wire bonded, and with resin containing one or more of epoxy, phenol or polyimide resins (see Abstract). In addition, Hozoji teaches several desired low water absorption rates being changes in weight over a period of time (see paragraph [0016] and Table 1). Hozoji does not teach a "water absorbtion of 1.5% by volume or less" as recited in claims 28. The Hozoji reference is silent with respect to the property of peel strength.

The Sakumoto et al. reference discloses an "adhesive tape" for electronic parts wherein the adhesive tape includes a heat resistant base film, and an adhesive layer laminated on at least one side of the base film, the adhesive layer comprising a resol type phenol resin and an acrylonitrile/butadiene copolymer (see Abstract). As admitted by the Examiner (Office Action, dated December 26, 2001, page 11, lines 13-16), Sakumoto et al. do not teach the particular combinations of compounds recited in claim 48. The Examiner argues that it would be a matter of routine experimentation to make such combinations. Applicant disagrees. The Sakumoto et

al. reference discloses the use of epoxy resins, acrylic resins, silicone resins and other resins (col. 9, lines 26-30). Applicants assert that the Sakumoto et al. reference generally discloses classes of compounds that are so broad as to justify that it would be a matter of "routine observation and experimentation" to come to the subject matter of claim 48. The list of compound classes disclosed by Sakumoto et al. does not mention "1,2(ethylene)bis(trimellitate anhydride)" as is recited in claim 48.

Sakumoto et al. is silent with respect to the property of peel strength.

Conclusion

Neither the Morita et. al. reference, nor the Hozoji et al. reference, nor the Sakumoto et al. reference teach that "the organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher" as recited in claim 17. Therefore, the *prima facie* case of obviousness is untenable and should be withdrawn. Furthermore, even if a *prima facie* case of obviousness could be reasonably established (which it can not), the experimental evidence provided by the Masuko Declaration clearly demonstrates unobvious and unexpected results pertaining to the invention of claim 17, thereby sufficiently rebutting and overcoming the rejection.

For all of the above reasons, claims 25-65 are in condition for allowance, and prompt notice of allowance is earnestly solicited. Questions are welcomed by the below-signed attorney for applicants.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

48. (Amended) A process according to claim 36, wherein the polyimide is a polyimide synthesized from a combination which is selected from the group consisting of a combination of 1,2-(ethylene)bis(trimellitate anhydride) and bis(4-amino-3,5-dimethylphenyl)methane; a combination of 1,2-(ethylene)bis(trimellitate anhydride) and 4,4'-diaminodiphenylether; a combination of 1,2-(ethylene)bis(trimellitate anhydride) and bis(4-amino-3,5-diisopropylphenyl)methane; a combination of 1,2-(ethylene)bis(trimellitate anhydride) and 2,2-bis[4-(4-aminophenoxy)phenyl]propane; a combination of a mixture of 1,2-(ethylene)bis(trimellitate anhydride) and 1,10-(decamethylene)bis(trimellitate anhydride) being the same mol as the mixture and 2,2-bis[4-(4-aminophenoxy)phenyl]propane; and a combination of 1,10-(decamethylene)bis(trimellitate anhydride) and 2,2-bis[4-(4-aminophenoxy)phenyl]propane.